

CONSTRUCTION

ABSTRACT

Constructed “mega-projects” are readily recognizable for their form and function, and in many cases, are awe-inspiring. Major buildings and bridges give identities to cities and nations and evoke a sense of pride in the people. The construction industry is a vast system of engineers, architects, laborers, craftsmen, material, equipment and tool suppliers, and project owners responsible for building these structures. The scope of the industry is all encompassing, including every type of facility imaginable. Roads, bridges, mass transit, airports, schools, retail and commercial buildings, industrial and manufacturing facilities, drinking water systems, wastewater treatment facilities, dams and power generation, solid waste facilities, and hazardous waste treatment and disposal projects all benefit society and bolster our national security. The construction industry seminar focused on projects and issues that have a potential mobilization involvement.

At \$3.4 trillion annually, construction represents a large contribution to the world's economy. Construction is a fiercely competitive industry; both domestically and internationally, reputation means everything. It is a conservative and risk-averse industry; change is gradual. Although the construction industry does not have a significant surge capability in healthy economic times, it is adaptable to national priorities and history verifies that that it can shift work to meet national security objectives.

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PLACES VISITED

Domestic

Associated General Contractors of America, Alexandria, VA
Bechtel Inc, San Francisco, CA
Boston Harbor/Central Artery Tunnel Project, MTA, Boston, MA
California DoT, Airport Bay Area Rapid Transit Extension, San Francisco, CA
Jacobs Engineering Inc, Pasadena, CA
Parsons-Brinkerhoff, New York, NY
Pentagon Renovation Project, Arlington, VA
Port Authority of New York/New Jersey Headquarters, New York, NY
Ralph Parsons Inc, Pasadena, CA
Sheet Metal Workers Union, Local 100, Suitland, MD
Stromberg Sheet Metal Works, Beltsville, MD
The Port of Oakland, Oakland, CA
The Washington Group, Boston, MA
U.S. Army Corps of Engineers, San Francisco District, CA
U.S Naval Mobile Construction Headquarters, Port Hueneme, CA
Virginia DoT, Springfield Interchange Project, Springfield, VA

International

Greece:

U.S. Embassy, Athens, Greece
Hellenic Military Construction Program (HNDGS Defense Planning and Program Directorate) (Greece Department of Defense)
Ministry of Environment, Zoning, and Public Works
ATTIKI ODOS Motorway (Beltway Around Athens)
Attiko Metro A.E. (Athens Subway)
Rion – Antirion Bridge Project

Thailand:

U.S. Embassy, Bangkok, Thailand
New Bangkok International Airport
Office of the Commission for the Management of Land Traffic (Thailand)
Metropolitan Rapid Transit Authority of Thailand (Bangkok, Thailand)
Underground Mass Transit System (Subway in Bangkok)

Honolulu, Hawaii:

U.S. Pacific Command, Headquarters Building
Naval Facilities Engineer Command - Ford Island Development Program, Hawaii

INTRODUCTION:

Unimpeded movement of people and things throughout a country is essential to economic strength and national security. Accordingly, this year's study focused on those types of projects that have strategic implications for the economy including highways, bridges, and mass transit systems. In 2001, the health of the construction industry follows the general economic health of the country. Construction is a fiercely competitive industry where reputation means everything and industry-leading firms invest significant resources in business development and work hard to ensure their clients are satisfied. It is a conservative and risk-averse industry, often based on relationships between project owners and construction firms. The industry is capable of responding and fully supporting national security requirements.

THE U.S. CONSTRUCTION INDUSTRY--CURRENT CONDITIONS

Structure. Construction contractors are divided into three major segments: general building contractors, heavy construction contractors, and special trade contractors. General building contractors build residential, industrial, commercial, and other buildings. Heavy construction contractors build sewers, roads, highways, bridges, tunnels, and other projects. Special trade contractors are engaged in specialized activities such as carpentry, painting, plumbing, and electrical work.

In 1997, there were about 667,000 construction companies with employees in the United States; 197,091 were general contractors and operative builders; 37,701 were heavy construction or highway contractors; 431,877 were special trade contractors.ⁱ About 80% of the firms are small contractors (workforce of fewer than 10), employing a little over 25% of all workers in the industry and accounting for about the same percentage of business construction spending activity.ⁱⁱ Firms employing more than ten workers account for about 75% of total employment and work value.

Labor. In the 1990's, total U.S. employment increased 23.8% to roughly 129 million people. Of that total, construction accounted for over 6.4 million jobs; general building 1.4 million; heavy construction 869 thousand; and special trade 4.1 million.ⁱⁱⁱ The participation of minorities and women in the industry has increased since 1983. Hispanics now represent the largest group of minorities in the industry (15%) and show the greatest advances in the trade skills. Since 1983, they have increased their skill level participation by 150%. African Americans are 7% of employment and have made minor gains in the skilled trades. Women comprise 2.5% of the workforce and are represented primarily in administrative and managerial jobs.^{iv}

Construction work is physically demanding, intellectually, conceptually and organizationally challenging, undertaken year-round under all kinds of climate and weather conditions. Financially, salaries are competitive with those in less physically demanding occupations and industries. While most people do not view the work as glamorous, the work is rewarding and the fruits of one's labor last for decades.

A major concern of the construction industry is the shortage of skilled workers in all major construction sectors. The National Association of Home Builders estimated that in the 1998-1999 approximately 40% of all trade workers hired were inexperienced.^v Although many labor unions are actively training members, less than a quarter of craft workers belong to labor unions. Because of related erosion in the availability of apprenticeship training programs, there are wide disparities in the expertise of construction workers primarily between those with and without apprenticeship training. The booming economy of the past decade has created a surge in construction projects, generating an increased demand for workers. Yet, the industry as a whole continues to have a difficult time attracting young people into the skill trades.^{vi}

To address the problem of shortage of skilled workers, the industry has begun developing innovative recruitment programs. In Texas, for example, the Associated Builders and Contractors has started talks with the Mexican government to help fill the need for up to 15,000 skilled construction workers needed to keep pace with the growth in Denton, Collin, Tarrant and Dallas counties.^{vii}

Spending. U.S. Census figures show that from 1980 to 1999 the annual value of construction dollars grew from \$274 billion annually to \$830 billion, an increase of over \$500 billion. This represents a strong annual growth rate of approximately 14% for 20 years. Private construction spending increased from \$210 billion to \$591 billion (14.1% annually). Public construction spending has increased from \$64 billion to \$173 billion (13.5% annually).^{viii}

Although growth is expected to slow somewhat in the near future, the U.S. construction industry is expected to remain healthy and will ease into its 10th straight year of growth. Employment growth of 9% is predicted through the year 2008. Heavy construction employment is projected to increase on average with the industry as a whole; growth is expected in highway, bridge and street construction, as well as to repairs to the aging, deteriorating infrastructure. Employment in the special trades is expected to outpace all other sectors of the industry. Not only are special trade skills going to be in demand for home repair and remodelling, the demand in building and heavy construction is on the rise. Remodelling should be the fastest growing sector of the housing industry.^{ix} The aging population and slowing population growth will result in reduced demand for new housing units, consequently, residential construction employment growth is expected to be slow. However, the demand for construction of high-technology medical treatment facilities and nursing or extended-care institutions is expected to increase.^x Industrial construction is expected to be stronger due to anticipated increases in exports by the manufacturing sector and the backlog of repairs and/or new construction delayed for several years. The technological trends favoring telecommuting, home offices, teleconferencing, temporary workforces, electronic shopping, inventory reductions, etc. may also effect non-residential construction. And lastly, in light of the education policies endorsed by the current Administration, an expected increase in school repairs and new construction is anticipated and may lead the building market in the coming decade.^{xi}

Another factor which will influence spending in the outyears is the Transportation Equity Act for the 21st century, or TEA-21, which authorized over \$217 billion in surface

transportation spending for fiscal years 1998-2004, which was a 44% increase in funding authorizations from its predecessor, the Intermodal Surface Transportation Act of 1991.^{xii} Overall, \$45 billion has been earmarked this year for the federal highway, transit, and airport improvement programs, almost \$3 billion more than expected.^{xiii} One of the reasons for this increase is the Revenue-Aligned Budget Authority (RABA). RABA adjusts TEA-21 spending levels as incoming revenues increase or decrease. Also adding to the funding stream are gas tax revenues in excess of those originally forecast in the original TEA-21 legislation.

Financing. A key to financing any project involves accurately identifying risk and mitigating it through sound financial and management techniques. The number of public private ventures has increased in recent years in order to share the financial investment load and mitigate the cost/schedule/performance risk. Another risk-reduction technique is the use of surety bonds, which is technically a form of insurance. The surety can benefit the contractor, by providing technical, management, and financial assistance as needed.^{xiv} Four types of bonds may be required depending on the complexity and the sector (public or private) of construction involved.^{xv} These are: (1) Bid Bonds, which provide financial assurance of good-faith bid and assurance that the contractor intends to contract at the price bid with requisite performance and payment bonds; (2) Performance Bonds, which protect the owner financially should contractor fail to perform in accordance with all terms and conditions of contract or default the contract; (3) Payment Bonds, which guarantee the contractor will pay key subcontractors, laborers, and materials associated with a project; and (4) Maintenance Bonds, which protect the owner from patent and latent defects for a specified time after project completion, if not covered by the performance bond.

Regulations/Codes/Standards. The construction industry is highly regulated by laws, standards and building codes (federal, state, and local) intended to protect the environment, the community, the safety and health of workers, and the quality of the product for the owner. Regulations, codes, and standards have had a positive affect on the industry, especially in the areas of quality and safety. However, some regulations, primarily in the areas of environmental impacts and pollution abatement, add time to project development and slow project execution.

A problem in the residential market is the absence of a national, uniform building code. Currently four “models” are available to be used as guides in drafting regulations to serve the domestic market. As a result, codes are often in conflict or change from one jurisdiction to the next. There is ongoing work to develop a uniform domestic standard supported by the National Association of Home Builders through its participation on the standards development committee established by the American National Standards Institute.

Internationally, the International Organization for Standardization (ISO) was established in Switzerland in 1947 with the purpose of developing common international standards. These standards are becoming more germane today in the global marketplace. The two ISO standards applicable to the construction industry are ISO 9000 (Quality Assurance and Business Practice Documentation) and ISO 4000 (Environmental

Management). Several large U.S. design and construction firms are ISO certified which represents that construction design and construction work management (especially in safety, health and environmental areas) will be carried out according to an agreed plan.

The U.S. construction industry has been reluctant to adopt the international metric standard. If U.S. industry intends to remain competitive worldwide, it must embrace the metric system. Construction firms that adopt accepted international standards increase their business opportunities and enjoy the benefits of being able to compete more efficiently in the international arena.

Delivery Systems. There are two primary project delivery systems owners can choose in developing a project management strategy for construction projects: Design-Build (DB) and Design-Bid-Build (DBB). Traditionally, in the U.S., Design-Bid-Build has been the predominant delivery system of choice; with this delivery system where design and construction are sequential and separately contracted with two contracts, one covering the design work of the architects and engineers, and the second covering the actual construction activity.^{xvi} Design-Build combines design and construction in a single contract with one responsible contracting party.^{xvii} The National Defense Authorization Act for FY 1996 cleared the way for increased use of Design-Build in DOD. The Navy and Air Force are using Design-Build extensively and the Army is moving significantly into design-build with a target of 25% for Military Construction in 2002, and a follow-on target of 50%. This development supports mobilization planning because of the requirement for the rapid infrastructure buildup at contingency locations requires the most streamlined procurement methods available. Design-build simplifies the delivery process by initiating one contract, instead of two. DoD construction agents – Army Corps of Engineers (USACE) and the Naval Facilities Engineer Command (NAVFAC) – are better prepared to manage design-build, in the event of mobilization. DoD selection of Design-Build procurements is projected to equal the number of Design-Bid-Build by 2005. Estimates by the Design-Build Institute of America (DBIA) state that, by 2015, Design-Build will represent the delivery system of choice for the entire economy.

Outsourcing and Privatization. Worldwide, there is a growing trend towards the outsourcing or “franchising” of the construction, operations, and maintenance of large infrastructure projects. For example, the Logistics Civilian Personnel Augmentation Program (LOGCAP) used by the DoD ensures the pre-planning of logistics and engineer contingency contracts that support short notice operations requiring limited to extensive base support functions at a reasonable cost to the government.^{xviii}

Privatization of public infrastructure continues to play a significant role in worldwide economic growth. Many aspects of the private sector, not available to the government, can improve both construction and maintenance of critical infrastructure through the mechanism of privatization. Build, Operate, Transfer is one method employed by firms arranging privatization and assuming risk for the operation of the completed facility for a period of time until their investment return is realized. Two examples of this are the Bangkok Metro and the Ring Road (beltway) of Athens, Greece. The Ring Road will be constructed, operated, and maintained through toll collection for

40 years in a joint venture. Through the collection of tolls, the contractor will maintain the system, pay construction loans, and make a profit. Outsourcing and privatization are discussed more fully in an essay featured below.

Information Technology (IT). The integration of information technology into construction processes has been progressing gradually, but at an increasing rate. Many firms are using AutoCAD and web-based project management systems; typically, use is limited to larger firms that can afford the investment in hardware and training. Very few firms have effectively integrated IT tools into the actual work processes on construction sites, though increasingly, the attention of the larger firms is focusing on the process. The smaller firms may have e-mail and simple project management software, but most tasks are accomplished using time-tested, labor-intensive methods. A bright spot in the industry is the training programs established by large firms such as Gilbane, Jacobs Engineering, and Bechtel. These firms have instituted their own in-house training programs to ensure that information technology is providing a return on investment.

Research and Development. Research and Development (R&D) in the construction industry includes a wide range of activities, such as project management and delivery methods; application of information technology to design, engineering and construction management; and development of innovative and more efficient materials and equipment. Best estimates of R&D investment in the U.S. for construction are 0.5% of gross revenues.^{xix} This percentage, amounting to slightly above \$4 billion in 2000, is below the average of other industrial sectors. The National Science Foundation, the Department of Transportation, and the National Institute for Standards and Technology support most construction R&D. There is no unified national strategy guiding R&D in the construction sector. As a result, while total U.S. R&D expenditures have risen since 1992, the nature and distribution of R&D spending is largely unchanged. Military R&D efforts by the Construction Engineering Research Laboratory and the Waterways Experiment Station of USACE, and the Naval Facilities Engineering Services Center of NAVFAC are focused on military uses of existing technology. Construction techniques and material improvements change gradually in the industry with continued reliance on basic materials such as steel, concrete, aluminum, wood, and masonry products. One example of an advance in construction materials is geotextile fabric developed by a Norwegian University Professor that was used to line the Attiki Metro tunnels in Athens. With investment in R&D, applications for many of the “leading edge” technologies, such as high performance construction materials, advanced composites, sensors, and nano-technology are achievable.

THE INTERNATIONAL CONSTRUCTION MARKET

The international construction marketplace is healthy. Engineering News-Record estimates the world construction market for 2000 at \$3.4 trillion, up 5.8% since 1998. Regionally, Asia led the way in construction spending with \$1.113T, followed by Europe with \$1.016T, the Middle East with \$1.012T, North America with \$884B, Latin America with \$241B, and Africa struggling in with \$56B.^{xx} The outlook for continued growth in the construction market is closely linked to prospects for the overall economic health in each region and country.

U.S. Involvement in the World Market. Although the construction marketplace is international, with many large firms doing work worldwide, the bulk of this work is in program and project management. Labor, materials, and equipment are seldom mobilized in the United States and shipped to overseas projects. Of the \$116 billion in overseas construction performed by U.S. firms in 1998, only \$4.1 billion was actually accomplished using a combination of exported labor, material, and equipment.^{xxi} In other words, big U.S. firms design, engineer, and manage construction with a large financial pass through of contracted amounts being paid to indigenous laborers and the international market for material and equipment. The same is true of international firms doing work in the United States. Labor and material for construction projects remains primarily local.

About half of the top 100 U.S. firms do work internationally. With few exceptions, smaller firms are less likely to work in the international market. The risks inherent in finding and competing for international projects are too great for most firms. The multi-cultural business environment, adapting to differing labor standards, managing long supply chains or adapting to unfamiliar local material suppliers, dealing with unpredictable government and political intervention make working independently risky. Most firms that do work internationally form partnerships with local firms to help them understand the local cultures and work practices. Even the giants like Bechtel, Fluor Corporation, Kellogg Brown and Root, and Parsons rarely tackle large projects without establishing local alliances that can guide them towards profitable work. These mega-firms establish offices worldwide to facilitate their involvement.

The larger U.S. firms have established a physical, long-term presence in regions that demonstrate continued business opportunities using alliances with well-established local firms to become familiar with the market. Luiz Rocha, the president and CEO of Odebrecht Construction (a large Brazilian Contractor doing work in the U.S.), uses a concept he calls “glocalization”- a corporate policy of thinking globally and acting locally. His company’s strategy is to be recognized as a local company everywhere it operates. They achieve this by hiring quality local professionals and becoming actively involved in the welfare of the communities.^{xxii}

Generally, projects must be big enough to be financially beneficial for international firms to take on the work. The rewards must outweigh the risks and difficulties described earlier. Most jobs are complex and call for firms that have vast experience and technical capability. For example, Parsons Corporation of Pasadena is building an \$800M facility in Russia to destroy chemical weapons as a part of the chemical de-militarization program. The project is not only high risk because of its unique nature, but Russia’s financial health is questionable. Parsons Brinckerhoff of New York, a worldwide leader in transportation infrastructure, is designing and managing construction of the \$10.7B West Coast Rail Link between London and Edinburgh, Scotland, while the firm of DMJM of Los Angeles provided engineering and consulting services to the new \$1B Bangkok Thailand International Airport.

Foreign (Europe, Japan, Canada, and Mexico) Penetration into U.S. Market. According to the Department of Commerce, foreign penetration of the U.S. construction

market is marginal but gradually expanding. In 1997, foreign imports of construction services were \$346M. Taisei Corporation, Japan's largest construction firm, completed the Toyota Proving Ground test track in Arizona in 1993 and has focused on constructing hotels and office buildings in the U.S. market. Canada's presence in the U.S. market is mostly confined to the border states. Mexico's construction industry does not have significant international influence nor expertise in large complex projects. However, one of Mexico's largest firms, ICA, has an alliance with Fluor Daniel, which will enhance their ability to expand into international markets.

CHALLENGES

The following three essays describe specific challenges within the construction industry. The first essay outlines trends, both within and outside the government, toward privatization. The second essay addresses the use of information technology and research and development within the industry. The final essay describes construction and the protection of U.S. facilities overseas in the context of recent terrorist acts.

PRIVATIZATION OF PUBLIC INFRASTRUCTURE AND DEFENSE SUPPORT

Privatization of public infrastructure continues to play a significant role in worldwide economic growth. The American Society of Civil Engineers estimates that the cost of repairing and renovating U.S. infrastructure is \$1.3 trillion.^{xxiii} Many capabilities of the private sector, which are not available to the government, can improve both construction and maintenance of critical infrastructure. Among these are the ability to be flexible, to gain access to personnel with special skills, to influence political support, and to use innovative techniques. Within the military-defense establishment, privatization can lead to the improvement of infrastructure, such as military housing, and in improvement of logistical services in low intensity conflicts.

Outlook. Privatization thrives in the U.S. and continues to grow internationally. In 1999, worldwide privatization accounted for over \$140 billion.^{xxiv} Despite the numerous obstacles to privatization of public systems, barriers are crumbling and many governments continue to realize benefits. The U.S. is quickly closing the gap in the global trend toward privatization due to changes in regulations, competitive advantage in information technology, mergers and acquisitions, and the demand for a more efficient and smaller government.

Much of the overseas construction market involves infrastructure privatization. Foreign countries privatize everything from airports to railroads, utilities and water treatment plants. The World Bank argues that in less-developed countries, the solution to poor service is greater private investment in facility development and operations. In 1997, \$40 billion in private capital was invested in developing nations' infrastructure.^{xxv} Although portions of the U.S. infrastructure are privatized, this represents only about 5 percent of worldwide privatization.^{xxvi} As privatization markets continues to grow, U.S.

firms are actively marketing for overseas privatization work. Western Europe leads the way toward privatization, but Latin America, along with Asia, provides the best opportunities today. Currency and stock fluctuations in Asia make many U.S. firms weary of aggressively pursuing prospects there.

Local and state governments in the U.S. continue to lead with the most interesting and innovative initiatives for privatization. Cost savings and increased quality of service have led them to privatization as the preferred method. For example, the State of Virginia utilizes privatization through initiatives such as employee stock ownership plans, surveys of commercial activities in the state, and production of a privatization and competition manual.

Additionally, a major trend in privatization is the trend toward mergers, acquisitions, and partnerships. This trend has two components in the construction sector. First, construction firms buy others to obtain access to new markets or to expand their capabilities. Second, utility companies often acquire construction firms so that they have better control over construction of facilities and power plants. For example, First Energy of Ohio bought 12 heating, ventilation and air-conditioning (HVAC) contractors to operate and maintain its' infrastructure and Duke Energy has a close partnership with construction giant Flour Daniel for work on power plants. Another trend in privatization is the expansion of construction firms into the field of operations and maintenance (O&M) of facilities. O&M is now the largest and fastest growing sector of business, amounting for as much as \$60 billion annually worldwide.^{xxvii}

As privatization efforts continue to increase, several barriers, particularly in the US, affect the ability of governments to privatize. These barriers include an abundance of regulations, inflexible labor prohibitions, and tax laws that favor retention of government functions. Through various legislative initiatives such as the National Partnership for Reinventing Government (1993), Federal Acquisition Streamlining Act (1994), and the Federal Acquisition Reform Act (1996), the U.S. Congress is making it easier to adopt privatization initiatives. These initiatives continue.

Tax laws such as the government bond exemption from taxation of interest are counterproductive to investor owned infrastructure. Federal grants and regulatory policies also discriminate against a facility owned by investors. Tax law reform, allowing tolls on interstate highways, extending tax-exempt status to revenue bonds regardless of ownership, and changing regulations to include privately owned wastewater plants under environmental regulations are potential ways of encouraging additional privatization.^{xxviii}

Government Roles and Goals. At the state and local levels, Design-Build-Operate projects continue to dominate. These projects allow the same firm or partnership to operate and maintain a structure or facility indefinitely. At the federal level, the Build-Operate-Transfer technique is widely used where a joint venture will build and operate a facility for a set amount of time, then transfer it to a government agency. The design-build-operate, asset sales, or franchise technique is often used internationally in

developing countries. For example, the Greek Attiki Odos Joint Venture is responsible for the construction, partial financing, and O&M of the Athens ring road (beltway) for period of 40 years after the completion of construction. Toll collections will pay the principal, interest, profit, and future O&M costs.

Many state and local jurisdictions encourage privatization through passage of enabling legislation. One example is the Michigan charter-school-law that has opened the way for private companies to run schools. Michigan also revised the collective-bargaining statute to further enhance outsourcing of cafeteria, custodial, transportation and other services. Georgia enacted legislation to abolish protection of civil-service jobs on the basis of ethnicity which allowed employees to be judged on performance. This legislation eased regulations and paved the way for the easier transfer of government jobs and functions to the private sector. The federal government could easily adopt similar initiatives and policies to encourage privatization.

Case Study #1 – Military Privatization of Housing

Under a typical U.S. Department of Defense (DoD) housing privatization contract, the military conveys some existing housing or property to a private developer. The developer then constructs or renovates housing units, and in some instances is responsible for continued management and maintenance of the units for as many as 50 years. Each occupant then pays his or her monthly housing allowance directly to the contractor. This enables the leveraging of housing allowance entitlements, which would otherwise be paid to individual landlords, to fund private joint ventures, which will improve housing for service members. The structure of each privatization deal varies, but procurements require the military services to provide some capital and/or property to the contractor and guarantee a pool of renters, in exchange for contractor constructed properties, renovations, and facility management.

Each service (Army, Navy/Marines, Air Force) approached this privatization in a slightly different manner, but initial efforts in Texas, Colorado, and Washington appear to show promise. Initial construction and renovation appears to occur faster in each of these instances because private joint ventures are providing capital, which would not otherwise be available from government-only sources. Some contracts are leveraging as many as twenty contractor dollars for every government dollar spent on housing improvement. Although it will take several years to fully assess the impact of these efforts, initial quality, customer service, and contractor motivation appear excellent.

On the international front, Australia took a bold step in creating the Defence Housing Authority (DHA), a semi-autonomous business entity, similar to the U.S. Postal Service. Broad ranging legislation gave all on and off-post military family housing units to the DHA for management. DHA received rent payments from the Department for these properties and set up an annual methodology to adjust the rental rates. By operating commercially, DHA borrowed funds, acquired (new construction, spot purchase, or direct lease) and disposed of housing units, and developed innovative solutions to housing challenges. DHA also managed a sale-leaseback program where it sold existing or newly constructed homes to investors who agreed to a six to nine year lease to the DHA.

Because of the excellent results, DHA assumed full responsibility for all aspects of housing military families in 2000.^{xxix}

Case Study #2 – Military Logistics Augmentation

Contractor tactical support to the military dates back as far as the Napoleonic Wars, the American Revolutionary War, Civil War, and World Wars I and II.^{xxx} Since the end of the Cold War, small-scale threats are requiring the presence of U.S. military forces in austere environments with little or no infrastructure for support. Additionally, many ground combat support (CS) and combat service support (CSS) are no longer in the active force structure. Privatized logistics support is proving essential during these peacekeeping and humanitarian (Military Operations Other Than War--MOOTW) missions. The U.S. Army formalized this concept in 1985 with the Logistics Civilian Augmentation Program (LOGCAP). LOGCAP is a cost-plus-award-fee contract that pre-plans and executes (if required) logistics and engineer contingency contracts to support short notice operations.^{xxxi} Under a typical contract, the contractor is reimbursed for all reasonable costs and is guaranteed a one-percent profit. Additionally, the contractor can earn an award fee of up to five percent for planning and eight percent for execution if cost controls, coordination, flexibility, and responsiveness maintain actual costs below estimated costs.^{xxxii}

Although each military service has slightly differing contracts (Air Force Contract Augmentation Program – AFCAP and the Navy/Marines Construction Capabilities Program - CONCAP) and requirements, DoD senior leadership is embracing these options. The reasons for this preference include enabling forces to concentrate on war fighting, minimizing the number of uniformed military personnel involved in a conflict, and maintaining flexibility for a myriad of operational missions. Experience proves that these contracts can successfully support construction of transportation, shelter, dining, storage, medical, water, security, and power generation facilities. Without this vital privatization support, the efforts of the U.S. and its allies to support contingency operations are seriously hindered. For example, since 1992, the Army successfully used LOGCAP in Somalia, Rwanda, Haiti, Italy, Bosnia, Kosovo, and East Timor.

Support in Bosnia illustrates the critical nature of LOGCAP. In 1997, the Army awarded a two-year sole source LOGCAP Bosnia-only contract to Brown and Root Services Corporation (BRS) to continue support there, even though DynCorp beat BRS (the incumbent) for the Army-wide LOGCAP contract. The reasons for this decision included the need for support continuity, uninterrupted operations, and uncertain mission length. In 1999, BRS won a one-year contract with four one-year options for Bosnia support, which will potentially extend their presence there until 2004. Besides helping to ensure stability in a highly sensitive region of the world, the benefits derived for the BRS extension include sustained construction, facility management, and services; and the preservation of a high quality of life for U.S. forces. Replacing a contractor responsible for critical logistical operations in a sensitive environment without the institutional knowledge and experience puts the safety and well being of the forces, and the overall mission at serious risk.

It is essential that the military leadership involved with these activities understand contractual responsibilities and procedures. Leaders must receive training on contractual duties, procurement methods, and cost avoidance. Commanders should establish review boards to approve new projects and the contracting officer and the contractor must be given early access to the mission area and be fully integrated into the commander's planning process. This ensures the flow of information in support of quick and timely command decisions, develops team cohesion, and minimizes the coordination obstacles that could affect the mission.

Summary. The U.S. government lags behind state and local governments in privatization initiatives, continues to be hampered with numerous regulations and barriers, but is closing the gap with other countries. As the economy continues to grow and the need for new and revitalized infrastructure continues, privatization expertise within U.S. firms is increasing. Many of these firms are poised to break into the international market. DoD has begun to successfully implement several initiatives. In addition to the case studies above, efforts such as the National Security Agency "break through" program are helping employees' transition to the private sector. Another example of successful privatization is the contracting of Air Force depot maintenance work at Hill Air Force Base, Utah for KC-135 and A-10 aircraft.

Through effective partnering and teamwork between DoD and civilian contractors, voids are being filled that enabling our forces and the nation to act with strength in support of national interests despite force structure limitations and the complex nature of the world environment. Each government agency must continue to look at the creation of systems that effectively integrate contractors into operations, monitor contractor performance, prevent the misuse of funds, and share lessons learned.
(Robert Davis, Jr., Stephen Kreider, and Joseph E. Pedone)

RESEARCH, DEVELOPMENT, AND INFORMATION TECHNOLOGY IN THE CONSTRUCTION INDUSTRY

Research and Development (R&D) in the construction industry includes a wide range of activities, such as project management and delivery methods; application of information technology to design, engineering and construction management; and development of innovative and more efficient materials and equipment. Engineering, building, and project owner/developers include industrial manufacturers, public works departments, public and private institutions, commercial and residential developers, and a collection of public and quasi-public entities. Academia (primarily funded by government sources), professional trade organizations, and research foundations such as the National Science Foundation, the National Institute of Standards and Technology, the Civil Engineering Research Foundation, and the American Society of Civil Engineers also conduct civil infrastructure systems research.

Within the U.S. government, the Army Corps of Engineers conducts R&D at eight laboratories that include the Waterways Experiment Station in Vicksburg, Mississippi, and the Construction Engineering Research Laboratory (CERL), co-located

with the University of Illinois in Champaign, Illinois. CERL is the lead laboratory for the Army's R&D efforts to improve construction, operations, and maintenance of its' installations. The Navy's primary construction R&D center is at the Naval Facilities Engineering Service Center (NFESC) in Port Hueneme, California. NFESC's construction research includes support for shore, ocean, and waterfront facilities for the Navy, Marine Corps, and other Department of Defense (DoD) organizations. The NFESC partners with CERL, as well as with the University of Washington and the University of Arizona. Although NFESC is involved in facilities R&D, the center is actually more active in *technology transfer* programs. Most of the Air Force's R&D is associated with space and air warfare. The Air Force Civil Engineer Support Agency (AFCESA) at Tyndall Air Force Base, Florida, conducts R&D that primarily focuses on *Fire Protection*.

The construction industry employed approximately 6.4 million workers and total revenues for the industry in the U.S. were approximately \$830 billion.^{xxxiii} Best estimates of R&D investment in the U.S. for construction are 0.5% of gross revenues.^{xxxiv} This percentage, amounting to slightly above \$4 billion in 2000, is woefully inadequate and is approximately one-seventh of the average of other industrial sectors. Similarly, a research firm in Connecticut reports that average information technology (IT) spending in highly efficient sectors such as the financial services industry is \$34,000 per employee, equivalent to 10% of revenue. In construction, annual IT spending is only \$835 per employee annually, a tiny 0.4% of revenue.

Outlook. In 1999, the National Science Foundation sponsored a construction R&D workshop comprised of a small influential group of industry executives. The group noted that construction research needs a greater sense of mission, focus, and industry support.^{xxxv} R&D in the construction sector lacks a unified strategy. While various private and governmental institutions conduct construction R&D, the "here-and-now" nature of the industry and the conservative mindset of practitioners prevent the development of a coordinated strategy. Although the U.S. is a world leader in the construction industry sector, many governments in industrialized countries take a more active role in focusing R&D towards their interests. In this context, a report published by Civil Engineering Research Foundation concluded that,

R&D activities are supported by governments as a contribution to national interests. Private and public sectors work together for common purposes of increasing export potential and improving domestic productivity.^{xxxvi}

While total U.S. R&D expenditures have risen since 1992, the nature and distribution of R&D spending is largely unchanged. Figures 1 and 2 show the 1992 distribution by sector and research.^{xxxvii} For example, many "leading edge" technologies, such as high performance construction materials, advanced composites, sensors, and nano-technology, are emerging, but there have been no significant breakthroughs for widespread use in the construction industry. The industry still relies on basic materials; such as steel, concrete, aluminum, wood, and masonry products. Although minor improvements in these materials have been made, construction techniques and material quality remain essentially the same now as compared to 20 years ago

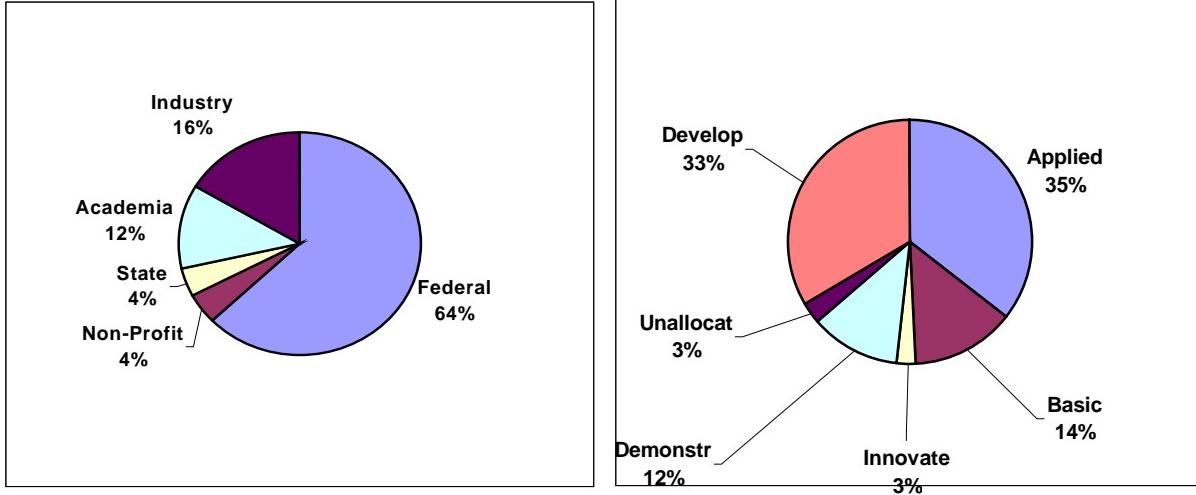


Figure 1: Construction R&D by Sector Figure 2: Construction R&D by Type

Construction projects can be considered as the world's biggest communication challenge as project teams consist of owners, bankers, city planners, review boards, engineers, general contractors, subcontractors, and others. Simply coordinating the members who participate one or more stages of the life cycle for projects is a daunting task fraught with inefficiencies, redundancies, missed deadlines, and missed opportunities. Minor oversights due to inefficient information flows before and during construction can snowball and require substantial revisions of project schedules, plans, and specifications, as well as generate costly change orders. The process-bound and paper-intensive world of engineering and construction operates on essentially razor thin margins—normally ranging between 1% and 2%—due in part to inefficiencies related to coordinating the planning and execution of the project among these team members. Like other major industry sectors, construction cuts across many trades including finance, engineering and design, field construction, manufacturing and distribution. The solutions include exchanges, marketplaces, and industry-specific business process optimization applications that aggregate industry product content, coordinate project teams, and bring together buyers and sellers. For years, project managers have implemented solutions such as contract management, document processing, and project scheduling software to reduce project expenses; nevertheless, the lack of integration remains a constant challenge.

Some construction executives cite a stubborn resistance in their industry to new technologies and to any new approaches to business. Construction has yet to adjust to today's business pace. Commercial property owners are under increasing business pressure to compress schedules and deploy buildings more rapidly. As fast-growth companies expand, they are challenged to go to market quickly. If they fail, the opportunity cost can be key as competitors capture the market. Last fall, the Houston Chapter of the Associated General Contractors' provided an opportunity for customers to compare web-enabled project management software. After this "shootout", several attendees told Engineering News-Record that they were hard-pressed to identify the value

that the systems had for them.^{xxxviii} The potential to keep the project on schedule is the single greatest potential benefit to using IT, but it is not always recognized.

Most construction R&D involves investigation of new light and low cost construction materials and improvements in construction design in order to make facilities more maintainable. Declining budgets are one of the most significant drivers in this effort in emphasizing maintenance. Examples of material research include: (1) development of plastic lumber-like materials, (2) development of composite materials for structural components, and (3) recycling of construction and demolition waste.

Government Roles and Goals. As part of the national military strategy to enhance power projection, most military related R&D supports design and construction of new facilities. In the case of the information technology, the Army's CERL developed knowledge based information systems that incorporate "lessons learned" and "best practices" for improving future construction projects. CERL also developed program management software applications. Navy IT R&D focuses on modeling techniques to simulate various factors associated with new mooring technologies. These modeling applications have been significant in assisting the Navy in development of stronger mooring lines, development of improved materials for pier construction, and design of piers adaptable for various classes of ships.

Unfortunately, the commercial sector is not benefiting from government IT research and appears to be seriously "lagging behind" in IT. The Army Corps of Engineers has been successful in partnering with various private and government organizations, but overall, commercial organizations could benefit more from these partnerships and capitalize on proven information technologies developed at the government's expense.

The government does recognize and allocate resources to infrastructure development, R&D, and IT; but there is no national center of responsibility for infrastructure policy, nor is there a clearly delineated statement of such a policy. Although several federal agencies have independent roles in the development or regulation of specific modes^{xxxix}, the National Research Council's Infrastructure and Construction Environment Board should develop a national research agenda for construction with particular emphasis on the following areas:

- Systems Life-Cycle Management (including acquisition and delivery systems)*
- Automated Analysis and Design Tools*
- Application of Information Systems (including the leveraging of e-commerce and web-based technologies)*
- Condition Assessment and Monitoring Technology*
- Advanced Construction Materials and Equipment*
- Improving dialogue between industry, academia and government.*

Summary. Construction is a complicated exercise in coordination, collaboration, and communication and is still, for the most part, a local industry that is heavily tied to relationships and loyalty. These relationships create a complex web of business processes that are necessary to get the job done on time and on budget. Smooth

collaboration throughout a project is critical to profitability. The sheer complexity of construction projects, combined with the reluctance of any one party to invest in expensive software and hardware, poses formidable barriers to automation. Most owners have not yet recognized IT as a powerful, strategic weapon in pursuit of greater profitability. Considering that communication information distribution costs typically represent approximate 5% of a project budget, a system that delivers dependable, real-time, intra-project communication and better collaborative information flows will allow more efficient allocation of budgetary resources. Such IT spending in the construction sector is minuscule when compared to other sectors. Advanced IT tools afford the construction industry with the opportunity to enhance global collaboration with improved communication flows and streamlined decision-making processes. At present, investment in and application of IT rests primarily in Tier 1 companies. IT will only penetrate this industry when the client/owners demand the efficiency and cost savings it can provide.

In the government sector, the ability to rapidly construct military facilities during mobilization is a core competency needed by DoD. Extending the lifespan and designing new facilities that require less maintenance are also important, especially during times of decreasing budgets. Improving project delivery methods and investigating new and efficient materials and construction processes need continued emphasis. In the civilian sector, construction projects engage us with allies and coalition partners. Through cooperation and construction technology sharing with these partners, the U.S. assists developing countries in the construction of transportation and other critical infrastructure. In the future, these developing countries may become “host nations” and our construction assistance now may prove essential in maintaining our nation interests tomorrow. The Infrastructure and Construction Environment Board of the National Research Council should be charged to develop a full national research agenda to further this goal.

(Margaret Kerr-McKown, Fred Newberry, Jaideep Sirkar)

DEPARTMENT OF STATE FORCE PROTECTION THROUGH CONSTRUCTION AND RENOVATION OF FACILITIES

The challenge to protect the employees and family members of military and Foreign Service employees overseas may be the single most important leadership issue currently facing the Department of Defense (DoD) and the Department of State (DoS). The U.S. embassy bombings in Kenya and Tanzania in 1998 as well as the Khobar Towers and USS Cole terrorist attacks on military forces are some of the most recent examples of bold and cruel attacks that dramatize the dangers U.S. personnel must risk to support interests abroad. The blast that tore a hole into the USS Cole and killed young sailors was heard most loudly in Washington, sending senior policy and military decision makers scrambling to take action to protect personnel from such heinous attacks. Although force protection is an issue that effects DoD and DoS personnel equally, this essay will examine the development and the current state of force protection for the DoS overseas embassies and facilities with the emphasis on the effective construction and renovation of existing structures.

Outlook. The catalyst that put State Department's force protection policies to the forefront came in the aftermath of the African embassy bombings. Subsequent accountability review boards made it clear that too low a priority was placed on force protection concerns. The findings in the report identified major deficiencies within embassy security policy to include: a lack of comprehensive policy providing common guidance for standards and procedures. The report was particularly critical of security measures taken to prevent car bombs, considering this method of attack has proven exceptionally effective against buildings—as evidenced by high-profile terrorist attacks in Beirut, Oklahoma, The World Trade Center, and Khobar Towers. The recent attack on the USS Cole used a pernicious maritime version of this tactic, with horrible consequences. National security assessments indicate that the outlook is for these “asymmetric” threats to continue and that the U.S. is vulnerable to these threats. Unless these vulnerabilities are addressed in sustained and financially realistic manner, the lives and safety of American employees in diplomatic facilities will continue to be at risk from further terrorist attacks.

The GAO force protection review requested by Congress stated that DoS encountered several management problems in using the \$ 1.47 billion it received to manage the diplomatic security construction program during fiscal years 1986-1995. The problems cited related to inadequate staffing, poor program planning, difficulties in sight acquisition, changes in security requirements, and inadequate construction contractor performance. Many of these shortfalls related to construction management of facilities and led to significant delays and cost increases.

Until recently, one shortfall of DoS was the inability to capture security deficiencies and lessons learned for all its overseas posts. There was not a central information system in place to track the condition or extent to which overseas facilities met security standards. In absence of this information, security requirements, most notably construction and renovation, were not fully known. Further, State was unable to easily determine the extent of existing upgrades already implemented. To correct this deficiency, State hired a contractor to develop a worldwide, automated security tracking system.

The Foreign Buildings Operations (FBO) office within DoS is responsible for managing construction of embassies and consulates as well as performing construction-related security upgrades and maintaining overseas properties valued at over \$ 12 billion. FBO has often come under scrutiny for cost overruns and an inability to accurately project funding requirements for its' construction programs. State attributes these shortcomings to several factors: additional project management support costs, unique design and structural requirements, increased material costs (due to stricter security requirements), and, most importantly, the challenge of working in developing countries with incompatible infrastructure. Many of these challenges are the same for any U.S. construction firm performing work overseas. FBO estimated that roughly 80 % of the 252 U.S. diplomatic outposts in 180 countries are vulnerable to terrorist attack. To secure those facilities, which house and employ more than 14,000 Americans, DoS began

what many characterize as most ambitious embassy campaign in its history. Estimates indicate that it will cost \$14 billion to upgrade all facilities worldwide.

Government Roles and Goals. DoS initiated the Security Enhancement Program in 1980 after the Iranian hostage crisis and other attacks on embassies worldwide. Five years later in the aftermath and shock of three bombings in Beirut, Lebanon, another advisory panel convened to assess worldwide embassy security. This panel identified 126 facilities with inadequate security and made wide sweeping recommendations to overhaul U.S. embassy security. The devastating results of two car bomb attacks in Kenya and Nairobi in August of 1998, however, forced DoS to realize that its efforts had fallen short.

In view of State's prior experiences and difficulties in implementing the security construction program, several questions and issues must be addressed as part of today's efforts to formulate strategies for enhancing security:

- How much will it cost to upgrade embassy security to appropriate security standards?
- How will the DoS structure the program planning process to manage major/multiple construction projects to ensure that competitive/best industry practices are used?
- What financial models will FBO use to effectively manage funds for overseas construction?
- How will DoS consolidate, disseminate, and track information to ensure oversight and security of its facilities worldwide?

In response to these questions and challenges, State implemented measures to ameliorate the inherent difficulties faced with managing program of this magnitude. First, State developed a 5-year program planning process, which lays out capital construction funding requirements, and programs to review design schemes in terms of cost-effectiveness to reduce the number of changes in project execution. The resulting program to renovate or construct new facilities at the most vulnerable locations is on an accelerated schedule. New, secure, embassies and consulates will take approximately 15 years to build and cost \$15 billion. The magnitude of this program will require State to work with the Congress and other U.S. agencies to determine priorities, time-lines, and annual funding. DoS will face numerous management challenges in administering an expanded security construction program, including whether it can bring on board the appropriate amount of staff to plan and manage a large number of overseas construction projects, simultaneously. In response to these requirements, the President's fiscal year 2001 budget included \$1.3 billion for embassy reconstruction projects and renovation. Additionally, another \$3.4 billion is programmed for fiscal years 2002 through 2005.

In an effort to bring best construction business practices to FBO, Secretary Powell named Major General (Retired) Charles Williams as the new chief of the FBO. General Williams, formerly of the U.S. Army Corps of Engineers, was known for his excellent management of the Dulles Airport toll road project and the New York City school

construction program. In a Senate Budget Committee hearing, Secretary Powell stated that significant progress was being made towards upgrading perimeter security fencing, but that DoS was still not moving fast or efficiently enough. He wanted to empower FBO to carefully study its construction practices to determine where it can improve efficiency. With this guidance, the FBO initiated several studies to develop better construction building methods to prevent potential industry bottlenecks that affect the industry. Powell emphasized that millions of dollars could be saved in embassy construction by modifying some of the safety guidelines with better and smarter construction designs and materials. For example, there is currently a 100 ft. setback distance from embassies to roads. In many cases, it is not physically possible or cost effective to acquire more land to maintain this setback. The FBO is currently seeking to relax this standard without compromising safety by using better construction techniques and materials to mitigate risks. As an example of using best construction business practices, FBO is using single design in multiple locations as well as pre-qualifying a pool of design firms to reduce delivery time and procurement. Moreover, in order to foster better teamwork and program development, key members from FBO work closely with each firms' project managers, as well as with the structural engineers and architects in resolving problems early on in the process.

Summary. Although the focus of this essay is primarily with DoS force protection policies and construction practices, and the DoD situation is similar, there are also unique differences. Most notably are the institutional differences in how the two organizations conduct overseas operations. Military bases are normally isolated, maintain their own security forces, and generally restrict host nation access. Embassies, however, present a unique dichotomy. An embassy's need to maintain security must be balanced with its challenge to promote an open and favorable image of the U.S.

Maintaining U.S. presence overseas will never be risk-free. The current use of car bombs is a rather unsophisticated method of attack that unfortunately has been used with deadly effect. Upgrading facilities to deter car bombings and other conventional attacks is critical in preventing current day threats. However, as technology progresses and terrorists become more sophisticated, there will be other modes of attack. With the development of chemical, biological, and radiological (CBR) technologies, attention must be given now to developing and providing integrated, real-time CBR detection devices, in addition to response capabilities in aftermath of an attack. Additionally, blast resistant technology and the use of advanced construction materials must be incorporated into all projects. Our government should encourage the research and development of these advanced technologies. *(Frederick Carter and Colin Kilrain)*

RECOMMENDATIONS

Initiatives like TEA 21 strengthen the industry. Ongoing domestic infrastructure projects, driven by federal, state, and local governments, are key enablers for economic growth and continued investment in our deteriorating infrastructure. National economic growth depends upon the mobility afforded by the elaborate network of highways, ports, manufacturing and industrial facilities and the utility systems that keep them running. Infrastructure does not last forever, so constant investment of capital is required to keep our nation's built environment functioning, thus maintaining our significant competitive advantage.

In this globalized economy, billions of dollars will be spent on infrastructure development around the world. U.S. firms must participate in, and be competitive in this market. The U.S. government can reduce the financial risk of competing in the international market by working with foreign governments to reduce the risk of unfair business practices and by providing tax incentives to U.S. firms that invest in foreign infrastructure projects.

CONCLUSION

Our history is rich with examples of construction industry support during war. For example, the massive island hopping and airbase buildup during the Pacific campaign in WWII, the base construction during Vietnam, and the combat service support to NATO forces in the Balkans, are just a few of the instances where construction contractor support was invaluable to the nation.

Although the construction industry does not have a significant surge capability in healthy economic times, it is adaptable to national priorities and can shift work to meet national security objectives. The industry's response to the bombing of the World Trade Center in 1993 and the San Francisco earthquake in 1989 are indicative of the speed at which response occurs. In both instances, firms dropped all ongoing work to respond to the call for help. Using a time and material contract in the World Trade Center bombing, the Port Authority of New York/New Jersey hired the original steel contractor, general contractor, and the Architect-Engineer firm to conduct damage assessment and commence the recovery.

In the end, one should consider that construction is still, for the most, a local industry that is heavily tied to relationships and loyalty. In a rapidly changing world, the construction industry, although slow to embrace change, is capable to meet the national security needs of the United States.

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